SPECIFICATION

HEAT EXCHANGER TUBE

TECHNICAL FIELD

The present invention relates to heat exchanger tubes in which a medium flowing through their passages conducts heat exchange with heat conducted to the tubes.

BACKGROUND ART

A heat exchanger such as a radiator, an evaporator or the like used for a refrigerating cycle is known that it is configured by alternately stacking flat heat exchanger tubes and corrugated radiating fins to form a core and connecting ends of the tubes to tanks. A refrigerant is taken into the heat exchanger from one of the tanks, flowed through the heat exchanger tubes while performing heat exchange with heat conducted to the core, and discharged out of the other of the tanks. Such a heat exchanger is produced by assembling the component members such as heat exchanger tubes, fins, tanks and the like into one body and brazing the assembled body in a furnace.

The heat exchanger tubes of the heat exchanger of the above type are also disclosed in the following Patent Documents 1 through 33. The heat exchanger tubes have the corrugated inner fins disposed within the tube body portion which configures the outer shell of the flow passages where the medium flows, so that the heat exchange efficiency of the medium can be improved. And, it is possible to improve the compression strength of the tubes

by brazing the inner fins to the inner surface of the tube body portion.

Patent Document 1: Japanese Patent Laid-Open Publication No. Sho 60-114698

Patent Document 2: Japanese Utility Model Laid-Open Publication No. Sho 61 8783

Patent Document 3: Japanese Patent Laid-Open Publication No. Sho 61-66091

Patent Document 4: Japanese Utility Model Laid-Open Publication No. Sho 62-8576

Patent Document 5: Japanese Utility Model Laid-Open Publication No. Sho 62 142440

Patent Document 6: Japanese Utility Model Laid-Open Publication No. Sho 63 134273

Patent Document 7: Japanese Utility Model Laid-Open Publication No. Sho 63 150721

Patent Document 8: Japanese Utility Model Laid-Open Publication No. Sho 63 159667

Patent Document 9: Japanese Utility Model Laid-Open Publication No. Sho 63-179472

Patent Document 10: Japanese Utility Model Laid-Open Publication No. Hei 1-8071

Patent Document 11: Japanese Patent Laid-Open Publication No. 4-198692

Patent Document 12: Japanese Patent Laid-Open Publication No. Hei 5-1893

Patent Document 13: Japanese Patent Laid-Open Publication No.

Hei 5-113297

Patent Document 14: Japanese Patent Laid-Open Publication No. Hei 5 169246

Patent Document 15: Japanese Patent Laid-Open Publication No. Hei 6-74607

Patent Document i6: Japanese Patent Laid-Open Publication No. Hei 6-129734

Patent Document 17: Japanese Patent Laid-Open Publication No. Hei 7-32133

Patent Document 18: Japanese Patent Laid-Open Publication No. Hei 7-265985

Patent Document 19: Japanese Patent Laid-Open Publication No. Hei 8 170888

Patent Document 20: Japanese Patent Laid-Open Publication No. Hei 8 271167

Patent Document 21: Japanese Patent Laid-Open Publication No. Hei 9 206980

Patent Document 22: Japanese Patent Laid-Open Publication No. Hei 10 197180

Patent Document 23: Japanese Patent Laid-Open Publication No. Hei 10-300382

Patent Document 24: Japanese Patent Laid-Open Publication No. Hei 11 101586

Patent Document 25: Japanese Patent Laid-Open Publication No. Hei 11-248383

Patent Document 26: Japanese Patent Laid-Open Publication No. Hei 11-257886

Patent Document 27: Japanese Patent Laid-Open Publication No.

Hei 11 264675

Patent Document 28: Japanese Patent Laid-Open Publication No. 2000-97589

Patent Document 29: Japanese Patent Laid-Open Publication No. 2000 105089

Patent Document 30: Japanese Patent Laid-Open Publication No. 2001-38439

Patent Document 31: Japanese Patent Laid-Open Publication No. 2001 107082

Patent Document 32: Japanese Patent Laid-Open Publication No. 2001 221588

Patent Document 33: Japanese Patent Laid-Open Publication No. 2002-350083

In recent years, the heat exchanger tubes tend to be made compact and precise in order to improve the performance of the heat exchanger. To improve the performance and the productivity, setting of sizes of individual components, arrangement of a brazing material and the like are becoming more and more significant conditions.

The present invention has been made in view of the above circumstances and an object of the invention is to provide heat exchanger tubes which are configured more reasonably based on the current production technology.

DISCLOSURE OF THE INVENTION

The invention recited in claim 1 of the present application is a heat exchanger tube comprising: a tube body portion

constituting an outer shell of flow passages for flowing a medium, and corrugated inner fins for dividing the flow passages, wherein tops of the inner fins are flat tubes brazed to the inner surface of the tube body portion and in which the medium performs heat exchange with heat conducted to the tubes, wherein a brazing material which is required for brazing the tops of the inner fins and the inner surface of the tube body portion is not clad to a first material constituting the tube body portion but clad to a second material constituting the inner fins.

The invention recited in claim 2 of the present application is the heat exchanger tube according to claim 1, wherein a thickness of a clad layer of the brazing material in the second material is 5 to 10% in ratio with respect to the thickness of the second material.

The invention recited in claim 3 of the present application is the heat exchanger tube according to claim 1 or 2, wherein the second material has a thickness of 0.1 mm or less.

The invention recited in claim 4 of the present application is the heat exchanger tube according to claim 3, wherein the second material has a thickness of 0.05 to 0.07 mm.

The invention recited in claim 5 of the present application is the heat exchanger tube according to any one of claims 1 through 4, wherein the first material has a thickness of 0.25 mm or less.

The invention recited in claim 6 of the present application is the heat exchanger tube according to claim 5, wherein the first material has a thickness of 0.18 to 0.24 mm.

The invention recited in claim 7 of the present application is the heat exchanger tube according to any one of claims 1 through

6, wherein the tube has a thickness of 1.2 mm or less.

The invention recited in claim 8 of the present application is the heat exchanger tube according to claim 7, wherein the tube has a thickness of 0.8 to 1.2 mm.

The invention recited in claim 9 of the present application is the heat exchanger tube according to any one of claims 1 through 8, wherein the tube has a width of 16 mm or less.

The invention recited in claim 10 of the present application is the heat exchanger tube according to claim 9, wherein the tube has a width of 12 to 16 mm.

The invention recited in claim 11 of the present application is the heat exchanger tube according to any one of claims 1 through 10, wherein the flow passages divided by the inner fins have an equivalent diameter of 0.559 mm or less.

The invention recited in claim 12 of the present application is the heat exchanger tube according to claim 11, wherein the flow passages divided by the inner fins have an equivalent diameter of 0.254 mm to 0.559 mm.

The invention recited in claim 13 of the present application is the heat exchanger tube according to any one of claims 1 through 12, wherein the tops of the inner fins have a pitch of 1.0 mm or less.

The invention recited in claim 14 of the present application is the heat exchanger tube according to any one of claims 1 through 13, wherein an Al-Zn alloy layer is formed on the surface of the first material which becomes an outer shell of the tube.

The invention recited in claim 15 of the present

application is the heat exchanger tube according to any one of claims 1 through 14, wherein the tops of the inner fins are flat.

The invention recited in claim 16 of the present application is the heat exchanger tube according to any one of claims 1 through 15, wherein ends of the second material in its breadth direction are brazed with the first material by the brazing material which is clad to the second material.

The invention recited in claim 17 of the present application is the heat exchanger tube according to claim 16, wherein both ends of the first material in its breadth direction are engaged and brazed with an end of the second material in its breadth direction sandwiched at one end of the tube in its breadth direction so as not to separate from each other.

The invention recited in claim 18 of the present application is the heat exchanger tube according to any one of claims 1 through 17, wherein the portion between the tops of the inner fins is not perpendicular with respect to the central axis of the tube in its breadth direction.

The invention recited in claim 19 of the present application is the heat exchanger tube according to any one of claims 1 through 18, wherein the tube is a constituting member of the heat exchanger, and the heat exchanger is produced by assembling the tubes and other constituting members into one body and brazing the assembled body in a furnace, and the brazing material clad to the second material melts when brazed in the furnace earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages thereby to prevent the flow passages from being clogged.

The invention recited in claim 20 of the present application is the heat exchanger tube according to claim 19, wherein the brazing material clad to the second material has a melting point lower than that of the brazing material which melts from the other constituting members and penetrates into the flow passages.

The invention recited in claim 21 of the present application is the heat exchanger tube according to claim 19, wherein the brazing material clad to the second material melts earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages because the tube has a thermal resistance lower than that of the other constituting members.

The invention recited in claim 22 of the present application is the heat exchanger tube according to any one of claims 19 through 21, wherein among plural flow passages divided by the inner fins, an equivalent diameter of the flow passage, which is positioned at the lowest position when brazing in the furnace, or individual equivalent diameters of the flow passage positioned at the lowest position and flow passages positioned nearby when brazing in the furnace are larger than a whole average of the equivalent diameters of the plural flow passages divided by the inner fins.

The invention recited in claim 23 of the present application is a heat exchanger tube comprising: a tube body portion constituting an outer shell of flow passages for flowing a medium, and corrugated inner fins for dividing the flow passages, wherein the tops of the inner fins are flat tube brazed to the

inner surface of the tube body portion and in which the medium performs heat exchange with heat conducted to the tube, wherein the tube has a thickness of 1.2 mm or less, the tube has a width of 16 mm or less, a first material constituting the tube body portion has a thickness of 0.25 mm or less, a second material constituting the inner fins has a thickness of 0.10 mm or less, and the flow passages divided by the inner fins have an equivalent diameter of 0.559 mm or less.

The invention recited in claim 24 of the present application is the heat exchanger tube according to claim 23, wherein the second material has a thickness of 0.05 to 0.07 mm.

The invention recited in claim 25 of the present application is the heat exchanger tube according to claim 23 or 24, wherein the first material has a thickness of 0.18 to 0.24 mm.

The invention recited in claim 26 of the present application is the heat exchanger tube according to any one of claims 23 through 25, wherein the tube has a thickness of 0.8 to 1.2 mm.

The invention recited in claim 27 of the present application is the heat exchanger tube according to any one of claims 23 through 26, wherein the tube has a width of 12 to 16 mm.

The invention recited in claim 28 of the present application is the heat exchanger tube according to any one of claims 23 through 27, wherein the flow passages divided by the inner fins have an equivalent diameter of 0.254 mm to 0.559 mm.

The invention recited in claim 29 of the present

application is the heat exchanger tube according to any one of claims 23 through 28, wherein the tops of the inner fins have a pitch of 1.0 mm or less.

The invention recited in claim 30 of the present application is the heat exchanger tube according to any one of claims 23 through 29, wherein an Al-Zn alloy layer is formed on the surface of the first material which becomes an outer shell of the tube.

The invention recited in claim 31 of the present application is the heat exchanger tube according to any one of claims 23 through 30, wherein the tops of the inner fins are flat.

The invention recited in claim 32 of the present application is the heat exchanger tube according to any one of claims 23 through 31, wherein ends of the second material in its breadth direction are brazed to the first material.

The invention recited in claim 33 of the present application is the heat exchanger tube according to claim 32, wherein both ends of the first material in its breadth direction are engaged and brazed with an end of the second material in its breadth direction sandwiched at one end of the tube in its breadth direction so as not to separate from each other.

The invention recited in claim 34 of the present application is the heat exchanger tube according to any one of claims 23 through 33, wherein the portion between the tops of the inner fins is not perpendicular with respect to the central axis of the tube in its breadth direction.

The invention recited in claim 35 of the present

application is the heat exchanger tube according to any one of claims 23 through 34, wherein the tube is a constituting member of the heat exchanger, and the heat exchanger is produced by assembling the tubes and other constituting members into one body and brazing the assembled body in a furnace, the brazing material which is required for brazing the tops of the inner fins and the inner surface of the tube body portion is disposed within the flow passages, and the brazing material disposed within the flow passages melts when brazed in the furnace earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages thereby to prevent the flow passages from being clogged.

The invention recited in claim 36 of the present application is the heat exchanger tube according to claim 35, wherein the brazing material disposed within the flow passages has a melting point lower than that of the brazing material which melts from the other constituting members and penetrates into the flow passages.

The invention recited in claim 37 of the present application is the heat exchanger tube according to claim 35, wherein the brazing material disposed within the flow passages melts earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages because the tube has a thermal resistance which is lower than that of the other constituting members.

The invention recited in claim 38 of the present application is the heat exchanger tube according to any one of claims 35 through 37, wherein among plural flow passages divided

by the inner fins, an equivalent diameter of the flow passage, which is positioned at the lowest position when brazing in the furnace, or individual equivalent diameters of the flow passages positioned at the lowest position and flow passages positioned nearby when brazing in the furnace are larger than a whole average of the equivalent diameters of the plural flow passages divided by the inner fins.

The invention recited in claim 39 of the present application is a heat exchanger tube comprising: a tube body portion constituting an outer shell of flow passages for flowing a medium, and a flow passage dividing body for dividing the flow passages the flow passage dividing body being a tube brazed to the inner surface of the tube body portion, and the medium performing heat exchange with heat conducted to the tube, wherein the tube is a constituting member of a heat exchanger, and the heat exchanger is produced by assembling the tube and other constituting members into one body and brazing the assembled body in a furnace, a brazing material which is required for brazing the flow passage dividing body and the inner surface of the tube body portion is disposed within the flow passages, and the brazing material disposed within the flow passages melts when brazed in the furnace earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages thereby to prevent the flow passages from being clogged.

The invention recited in claim 40 of the present application is the heat exchanger tube according to claim 39, wherein the flow passage dividing body is a corrugated inner fins, and the tops of the inner fins are brazed to the inner

surface of the tube body portion.

The invention recited in claim 41 of the present application is the heat exchanger tube according to claim 39, wherein the flow passage dividing body is beads obtained by shaping a material constituting the tube body portion, and the tops of the beads are brazed to the inner surface of the tube body portion.

The invention recited in claim 42 of the present application is the heat exchanger tube according to any one of claims 39 through 41, wherein the brazing material disposed within the flow passages has a melting point lower than that of the brazing material which melts from the other constituting members and penetrates into the flow passages.

The invention recited in claim 43 of the present application is the heat exchanger tube according to any one of claims 39 through 41, wherein the brazing material disposed within the flow passages melts earlier than the brazing material which melts from the other constituting members and penetrates into the flow passages because the tube has a thermal resistance which is lower than that of the other constituting members.

The invention recited in claim 44 of the present application is the heat exchanger tube according to any one of claims 39 through 43, wherein the flow passages divided by the flow passage dividing body have an equivalent diameter of 0.559 mm or less.

The invention recited in claim 45 of the present application is the heat exchanger tube according to claim 44, wherein the flow passages divided by the flow passage dividing

body have an equivalent diameter of 0.254 mm to 0.559 mm.

The invention recited in claim 46 of the present application is the heat exchanger tube according to any one of claims 39 through 45, wherein among plural flow passages divided by the flow passage dividing body, an equivalent diameter of the flow passages, which is positioned at the lowest position when brazing in the furnace, or individual equivalent diameters of the flow passage positioned at the lowest position and flow passages positioned nearby when brazing in the furnace are larger than a whole average of the equivalent diameters of the plural flow passages divided by the inner fins.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory diagram showing a heat exchanger according to an embodiment of the present invention (First embodiment).

Fig. 2 is an explanatory diagram and an enlarged view of an essential portion showing sections of a heat-exchanger tube, before brazing thereof, according to the embodiment of the present invention (First embodiment).

Fig. 3 is an explanatory diagram showing a section of a second material according to the embodiment of the present invention (First embodiment).

Fig. 4 is an enlarged diagram of an essential portion showing a section of a heat-exchanger tube, before brazing thereof , according to an embodiment of the present invention (Second embodiment).

Fig. 5 is an enlarged diagram of an essential portion

showing a section of a heat-exchanger tube, before brazing thereof , according to an embodiment of the present invention (Third embodiment).

Fig. 6 is an enlarged diagram of an essential portion showing a section of a heat-exchanger tube, before brazing thereof, according to the embodiment of the present invention (Third embodiment).

Fig. 7 is an enlarged diagram of an essential portion showing a section of a heat-exchanger tube, before brazing thereof , according to the embodiment of the present invention (Third embodiment).

Fig. 8 is an explanatory diagram showing a section of a heat-exchanger tube, before brazing thereof, according to an embodiment of the present invention (Fourth embodiment).

BEST MODE FOR CARRYING OUT THE INVENTION

A first embodiment of the invention will be described below with reference to Fig. 1 through Fig. 3.

A heat exchanger 1 shown in Fig. 1 is a radiator for a refrigerating cycle for in-car air conditioning mounted on an automobile. This heat exchanger 1 comprises a core 10 which is formed by alternately stacking heat exchanger tubes 100 and radiating fins 20, and a pair of tanks 30 with which both ends of the individual heat exchanger tubes 100 in their longitudinal direction are in communicative connection.

Reinforcing members 40 each is disposed on upper and lower sides of the core 10, and both ends of the individual reinforcing members 40 in their longitudinal direction are supported by the

tanks 30.

An inlet 31 and an outlet 32 for a medium (namely, a refrigerant which circulates through the refrigerating cycle) are disposed at the required portions of the tanks 30, so that the medium which has entered through the inlet 31 flows through the heat exchanger tubes 100 while performing heat exchange with heat conducted to the core 10 and flows out through the outlet 32.

Constituting members of the heat exchanger 1, such as the fins 20, the tanks 30, the inlet 31, the outlet 32, the side plates 40 and the heat exchanger tubes 100 are formed of an aluminum or aluminum alloy member. They are assembled into one body by means of a jig, and the assembled body undergoes a heat treatment in a furnace to be brazed into one body. To braze in the furnace, a brazing material and flux are disposed on the required portions of the individual members.

The heat exchanger tube 100 of this embodiment shown in Fig. 2 has a tube body portion 200 which forms the outer shell of flow passages 101 for flowing the medium and corrugated inner fins 300 for dividing the flow passages 101 and the tops of the inner fins 300 are flat and brazed to the inner surface of the tube body portion 200.

This heat exchanger tube 100 has a thickness t_{tube} of 1.2 mm or less. It is desirable that the heat exchanger tube 100 has a thickness t_{tube} of 0.8 to 1.2 mm. And, the heat exchanger tube 100 has a width w_{tube} of 16 mm or less. It is desirable that the heat exchanger tube 100 has a width w_{tube} of 12 to 16 mm. Besides, the individual flow passages 101 divided by the

inner fins 200 each having an equivalent diameter of 0.559 mm or less. It is desirable that the flow passage 101 has an equivalent diameter of 0.254 mm to 0.559 mm.

An equation to obtain the equivalent diameter de is de=4×(flow passage sectional area)/(overall length of wet edge of flow passage cross section). The medium performs heat exchange with heat conducted to the heat exchanger tubes 100.

The tube body portion 200 is formed by roll forming a first material of an aluminum or aluminum alloy strip. Both ends 201 of the first material in its breadth direction are mutually engaged and brazed at one end 102 of the heat exchanger tube 100 in its breadth direction so that they are not separated from each other. And, the other end 103 of the heat exchanger tube 100 in its breadth direction is a portion where substantially a center of the first material is bent.

The inner fins 300 are formed by roll forming a second material of an aluminum or aluminum alloy strip. Pitch P between the tops of the inner fins is 1.0 mm or less. The inner fins 300 are inserted between the first materials in an appropriate stage of the roll forming of the tube body portion 200 and disposed within the tube body portion 200.

In this embodiment, the brazing material, which is required for brazing the tops 310 of the inner fins 300, which are a flow passage dividing body to the inner surface of the tube body portion 200, is not clad to the first material which forms the tube body portion 200 but to the second material which forms the inner fins 300.

Specifically, in a case where the tops 310 of the inner

fins 300 and the inner surface of the tube body portion 200 are brazed, at least one of the first material and the second material is clad with the brazing material, and the structure of cladding only the second material with the brazing material is adopted in this embodiment. The reason for this is to suppress the use of brazing material to a minimum required quantity. Its concept will be described below.

First, the brazing material containing silicon is indispensable for brazing but becomes a cause of eroding the core material after brazing. Therefore, it is desirable that the brazing material is suppressed to a quantity as small as possible. And, a material clad with the brazing material is produced by stacking and rolling the core material and the brazing material at a prescribed ratio, so that the thickness of the clad layer of the brazing material has a lower limit with respect to the thickness of the material. According to the present technology, the lower limit of the thickness of the clad layer is about 5% with respect to the thickness of the material.

Besides, where thickness t_1 of the first material and thickness t_2 of the second material are compared, the thickness t_2 of the second material can be made thinner to some extent in view of the structure of the heat exchanger tube 100. As a result, only the second material is desirably clad with the brazing material to determine the brazing material to a small quantity.

Meanwhile, the ends 201 of the first material are brazed with the brazing material, which penetrates from the tanks 30 by capillary action, by brazing in the furnace described above.

According to this configuration, the quantity of the brazing material to be used can be reduced, and the depth of a silicon diffusion layer of the first material can be decreased, so that the thickness of the first material can be made thinner.

For improvement of support strength of the inner fins 300 to the tube body portion 200 and durability of the inner fins 300, the ends 301 of the second material in its breadth direction are brazed to the first material with the brazing material which is clad to the second material. Brazing of the ends 301 of the second material to the first material prevents the ends 301 of the second material from being fluctuated by the flowing medium, and the durability of the heat exchanger tubes 100 and the stability of the medium flow can be improved surely.

The thickness t_1 of the first material is 0.25 mm or less. It is desirable that the thickness t_1 of the first material is 0.18 to 0.24 mm. And, an Al-Zn alloy layer is disposed as a sacrifice layer for improving corrosion resistance of the heat exchanger tubes 100 on the surface of the first material which becomes the outer shell of the heat exchanger tube 100.

Meanwhile, the second material is formed by disposing a clad layer 300b of the brazing material on both surfaces of a core material 300a as shown in Fig. 3, and its thickness t_2 is 0.1 mm or less. It is desirable that the thickness t_2 of the second material is 0.05 to 0.07 mm. And, the thickness of the clad layer 300b of the brazing material in the second material is 5 to 10% in ratio with respect to the thickness t_2 of the second material.

In this embodiment, the tops 310 of the inner fins 300

are flat, so that sufficient brazing areas are secured between the tops 310 of the inner fins 300 and the inner surface of the tube body portion 200.

In other words, brazing strength and reliability of brazing are improved surely by configuring as described above. And, friction between the tube body portion 200 and the inner fins 300 is increased because the tops 310 of the inner fins 300 are flat. Thus, there is also an advantage that when the heat exchanger tube 100 is cut to a prescribed length before brazing, displacement of the inner fins 300 can be prevented. Width W_{flat} of the flat portions of the tops 310 is 2.5 to 0.5 when the thickness t_2 of the material is 1.

Besides, a portion between the tops 310 and 310 of the inner fins 300 becomes non-perpendicular to a central axis L of the heat exchanger tube 100 in its breadth direction. Specifically, an intersection angle θ between the portion between the tops 310 and 310 of the inner fins 300 and the central axis L in the breadth direction is 65 to 85°. In a case where the intersection angle θ is perpendicular and the heat exchanger tubes 100 is cut to a prescribed length before brazing, the inner fins 300 are largely deformed when a cutting blade is moved in parallel to the central axis L in the breadth direction. But, such a disadvantage is avoided in this embodiment by setting the intersection angle θ to a favorable value.

In this embodiment, where the brazing is effected in the furnace, the brazing material which is clad to the second material melts earlier than the brazing material, which melts from the other constituting members such as the tanks 30 constituting

the heat exchanger 1 and penetrates into the flow passages 101, thereby to prevent the flow passages 101 from being clogged. If the interior of the heat exchanger tube 100 is dry when the brazing material penetrates into the flow passages 101 from outside, the penetrated brazing material stays locally within the flow passages 101 because of an influence of its surface tension and the like, and the flow passages 101 are clogged. The brazing material which is clad to the second material has a melting point lower than that of the brazing material which melts from the surfaces of the tanks 30 and penetrates into the flow passages 101. Otherwise, the brazing material which is clad to the second material melts earlier than the brazing material which melts from the surface of the tanks 30 and penetrates into the flow passages 101 because a thermal resistance of the heat exchanger tubes 100 is smaller than that of the tanks 30.

Besides, to prevent the flow passages 101 from being clogged, among the plural flow passages 101 divided by the inner fins 300, the equivalent diameter of the flow passage 101, which is positioned at the lowest position when brazing in the furnace, or the individual equivalent diameters of the flow passage 101 which is positioned at the lowest position and the flow passages 101 which are positioned nearby when brazing in the furnace are desirably determined to be larger than a whole average of the equivalent diameters of the plural flow passages 101 which are divided by the inner fins 300.

It is because the melted brazing material tends to move in a direction of gravitational force, so that the flow passage

101 which is positioned at the lowest position when brazing in the furnace and the flow passages 101 which are positioned nearby tend to have a large amount of the penetrated brazing material in comparison with the other flow passages 101.

In this embodiment, the heat exchanger 1 is brazed in the furnace with the core 10 laid on its side, so that the equivalent diameter of the flow passage 101 which is positioned at one end 102 of the heat exchanger tube 100 in its breadth direction is determined larger, and if necessary, the equivalent diameter of the flow passage 101 positioned near the pertinent flow passage 101 is also determined to be large. Otherwise, the equivalent diameter of the flow passage 101 which is positioned at the other end 103 of the heat exchanger tube 100 in its breadth direction is determined to be large, and if necessary, the equivalent diameter of the flow passage 101 which is positioned near the pertinent flow passage 101 is also determined to be large.

Where the equivalent diameter of the flow passage 101 which is positioned near the flow passage 101 which is positioned at one end 102 or the other end 103 is determined to be large, a pitch P of the tops at the required portions of the inner fins 300 is determined to be larger than a pitch P of the tops at the other portion.

Besides, when the equivalent diameter of the flow passage 101 at the one end 102 and the equivalent diameter of the flow passage 101 at the other end 103 are determined to be large, either end may be positioned on the lower side, so that it is also possible to secure generality in terms of brazing posture.

As described above, the heat exchanger tube 100 of this

embodiment is configured very rationally and can be used favorably as a component part of the heat exchanger 1. Setting of the values of the individual portions of the heat exchanger tubes 100 was obtained by studying the performance of the heat exchanger tubes 100 based on the current manufacturing technology.

It should be noted that the structure of this embodiment can be changed in its design appropriately without departing from the technical scope recited in the appended claims and is not limited to the illustrated one.

Then, a second embodiment of the invention will be descried with reference to Fig. 4.

As shown in Fig. 4, the heat exchanger tube 100 of this embodiment has both ends 201 of the first material in its breadth direction mutually engaged and brazed at one end 102 of the heat exchanger tube 100 in its breadth direction so that they are not separated from each other. And, the other end 301 of the second material is brazed with the end 201 of the first material. The other basic structure is same with that of the above-described embodiment.

Thus, the end 301 of the second material may be brazed to the end 201 of the first material.

A third embodiment of the present invention will be described with reference to Fig. 5 through Fig. 7.

As shown in Fig. 5, the heat exchanger tube 100 of this embodiment has both ends 201 of the first material in its breadth direction mutually engaged and brazed at one end 102 of the heat exchanger tube 100 in its breadth direction with the end 301

of the second material in its breadth direction sandwiched so that they are not separated from each other.

The end 201 of the first material and the end 301 of the second material are brazed with the brazing material which is clad to the second material and the brazing material which penetrates from the tanks 30.

A shape of the end 201 of the first material and a shape of the end 301 of the second material can be determined appropriately as shown in, for example, Fig. 6 and Fig. 7, and are not limited to a particular shape. The other basic structure is same with that of the above-described embodiment.

Thus, the end 301 of the second material may be configured to sandwich the end 201 of the first material. According to this embodiment, the ends 201 of the first material can be mutually brazed with the brazing material which is clad to the second material. In a case where the ends 201 of the first material in its breadth direction are mutually brazed with only the brazing material which penetrates from the tanks 30, there is a case that the brazing material does not spread sufficiently if the heat exchanger tube 100 is relatively long, and defective brazing may be caused. In this connection, such a defect can be avoided by this embodiment, and the brazing of the ends 201 of the first material in its breadth direction can be improved surely in its reliability.

And, the end 301 of the second material in its breadth direction is sandwiched between both ends 201 of the first material in its breadth direction, so that the inner fins 300 can be positioned accurately within the heat exchanger tube 100.

Especially, the size of the flow passage 101 at one end 102 and the other end 103 of the heat exchanger tube 100 can also be controlled accurately. And, a decrease in resistance to pressure due to displacement of the inner fins 300 can also be prevented.

Then, a fourth embodiment of the present invention will be described with reference to Fig. 8.

As shown in Fig. 8, in the heat exchanger tube 100 of this embodiment, beads 202 which are formed by shaping the required portions of the first material are disposed as a flow passage dividing body for dividing the flow passages 101. The tops of the beads 202 are brazed to the inner surface of tube body portion 200.

The brazing material which is required for brazing the tube body portion 200 with the tops of the beads 202, and the brazing material which is required for brazing the both ends 201 of the first material, are clad to one surface of the first material which becomes the inside of the flow passages. When brazing in the furnace, the brazing material which is clad to the first material melts earlier than the brazing material which penetrates from outside into the flow passages 101, so that the flow passages 101 are prevented from being clogged. And the other basic structure is same with that of the above-described embodiment.

Thus, the beads can also be disposed as the flow passage dividing body. In such a case, the brazing material is clad to the first material, and to braze in the furnace, it is configured so that the brazing material melts earlier than the brazing

material, which melts from the other constituting members constituting the heat exchanger, and penetrates into the flow passages 101.

INDUSTRIAL APPLICABILITY

The heat exchanger tubes of the present invention can be used as constituting members of, for example, a vehicle-mounted heat exchanger.